

# **Extended Phase I Geoarchaeological Explorations for the Yosemite Slough Restoration Project, Candlestick Point Recreation Area, San Francisco, California**

*Prepared by:*

Philip Kaijankoski, M.A.

Jack Meyer, M.A.

August 2011 DRAFT

*Submitted to:*

Steve Hilton  
Associate State Archaeologist  
California Department of  
Parks and Recreation  
Northern Service Center  
One Capitol Mall, Suite 410  
Sacramento, CA 95814



FAR WESTERN ANTHROPOLOGICAL RESEARCH GROUP, INC.  
2727 Del Rio Place, Suite A, Davis, California, 95618  
<http://www.farwestern.com> 530-756-3941

**Extended Phase I  
Geoarchaeological Explorations for the  
Yosemite Slough Restoration Project,  
Candlestick Point Recreation Area,  
San Francisco, California**

*Prepared by:*

Philip Kaijankoski, M.A.

Jack Meyer, M.A.

August 2011 DRAFT

*Submitted to:*

Steve Hilton

Associate State Archaeologist

California Department of Parks and Recreation

Northern Service Center

One Capitol Mall, Suite 410

Sacramento, CA 95814

## TABLE OF CONTENTS

<b>1. INTRODUCTION .....</b>	<b>1</b>
Project Description .....	1
<b>2. BACKGROUND .....</b>	<b>6</b>
Geoenvironmental History and Setting .....	6
Site History .....	7
Landscape Evolution and the Archaeological Record .....	7
Buried Archaeological Sites in the Bay Region .....	10
Buried Site Problem .....	12
Previous Archaeological Studies .....	12
<b>3. SCOPE OF WORK .....</b>	<b>15</b>
Field and Laboratory Methods .....	15
Stratigraphic Identification and Soil Description .....	15
<b>4. STUDY RESULTS.....</b>	<b>19</b>
Summary and Buried Site Potential.....	19
<b>5. CONCLUSIONS .....</b>	<b>21</b>
<b>REFERENCES CITED .....</b>	<b>22</b>

## APPENDICES

Appendix A. Core Descriptions.

## LIST OF FIGURES

Figure 1. Study Vicinity Map .....	3
Figure 2. Study Location Map.....	4
Figure 3. Project Area and Embayment Locations. ....	5
Figure 4. Historic-Era Landscape of the Project Area with Known and Predicted Prehistoric Archaeological Site Locations.....	8
Figure 5. Project Area overlain on Quaternary Geology Map.....	9
Figure 6. Selected Buried Sites in the Southern San Francisco Bay Area. ....	11
Figure 7. Project Area in Relation to Known and Predicted Prehistoric Site Locations. ....	14
Figure 8. Fieldwork Photos. ....	16
Figure 9. Project Area and Core Locations. ....	17

## LIST OF TABLES

Table 1. Key for Subordinate Soil Horizons. ....	18
Table 2. Summary of Cores Drilled in Project Area.....	20

## 1. INTRODUCTION

On behalf of California Department of Parks and Recreation, Far Western Anthropological Research Group, Inc. (Far Western) conducted Extended Phase I subsurface geoarchaeological investigations in support of the Yosemite Slough Restoration Project. The 34-acre Yosemite Slough restoration area is located at the north end of Candlestick Point State Recreation Area in the city and county of San Francisco (Figure 1 and Figure 2). The planned restoration of wetlands will require the excavation of three new embayments to depths ranging from 2.4 to 5.5 meters (eight to 18 feet) below surface. At present the surface of the project area is composed entirely of artificial fill from wetland and bay reclamation during the twentieth century. Given that the project area is situated near the historic-era bay margins where many prehistoric archaeological sites are located, excavation work has the potential to impact buried sites that may be preserved under the artificial fill.

The involvement of federal funds requires compliance with Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800, revised 2004); in addition, the project falls under the California Environmental Quality Act (CEQA; Public Resources Code Section 21000 et seq., revised 2009). These regulation mandate that federal and California public agencies consider the effects of their projects on historic properties (i.e., resources eligible for the Nation Register of Historic Places and/or the California Register of Historical Resources).

Previous cultural resources studies conducted for the project, including a records search and site visit, determined the project area to be highly sensitive for buried archaeology sites. For these reasons the Initial Study/Mitigated Negative Declaration report for this project stipulated that all project related ground disturbance be monitored by a qualified archaeologist (WRA 2006). This approach, however, can be very time consuming and expensive, especially considering the costly project delays that can result from the discovery of an archaeological site during construction. For these reasons Far Western conducted Extended Phase I explorations in the project area to determine the presence or absence of buried prehistoric archaeological sites in advance of project construction. Extended Phase I investigations are commonly employed to search for archaeological deposits, as an extension of pedestrian survey efforts, in areas of high sensitivity where such deposits may be buried by sediment deposition or artificial fill.

This report documents the methods, results, and findings of this investigation conducted in the project area on July 6 and 7, 2011 by Far Western personnel. The exploratory work consisted primarily of hydraulic continuous core soil sampling performed by Far Western Geoarchaeologist Philip Kaijankoski, M.A., under the direction of Principal Investigator Brian F. Byrd, Ph.D., and Principal Geoarchaeologist Jack Meyer, M.A. These individuals have many years of experience in California archaeology and exceed the required qualifications for Archeology as defined by the US Department of Interior.

No archaeological materials were identified as a result of this work.

This report describes the nature and extent of the major subsurface strata identified, discusses the substantive findings from the project area as a whole, assesses the potential for the project area to contain intact prehistoric archaeological deposits, and makes recommendations for additional archaeological identification efforts, if necessary.

## PROJECT DESCRIPTION

The purpose of this project is to help restore essential wildlife habitat, improve water quality, and prevent erosion along the shoreline of the City of San Francisco—an area of the bay where tidal wetlands have been most impacted and suffered the greatest loss due to urbanization.

The proposed project would add approximately 12 acres of wetlands to the tidally influenced area of Yosemite Slough and create two new islands for bird nesting. Three embayments (referred to as North A embayment, North B embayment, and the South embayment) will be excavated to a maximum depth of ten, eight, and 18 feet below surface respectively (Figure 3). This will require removal of approximately 263,000 cubic yards of soil and debris. The proposed restoration project would involve inland excavation only, and no dredging would occur within the slough. Due to presence of hazardous materials, excavated soils will be treated either

onsite, offsite, removed to appropriate disposal facility, or covered to protect the environment and public health. Shallow impacts will occur elsewhere in the project area from vegetation and debris removal. Once excavation is complete the entire area will be planted with appropriate native species. Additional project components include constructing a trail system and vista points, a multi-use interpretive center comprised of an open air A-frame structure with 30-x-40-foot footprint, construction of a 200-x-60-foot parking lot, and upgrading gates that provide access to the site.

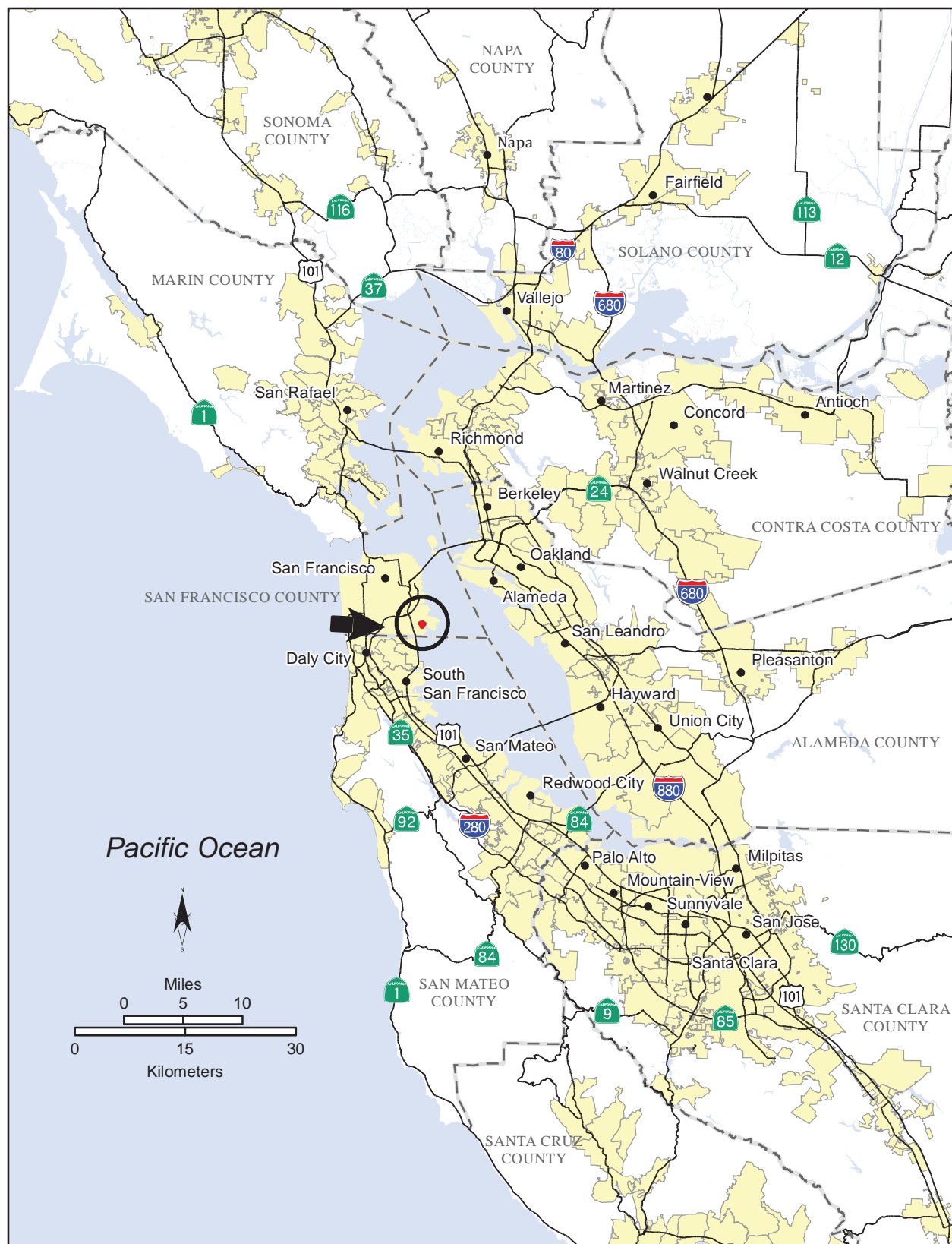


Figure 1. Study Vicinity Map.





Figure 2. Study Location Map.



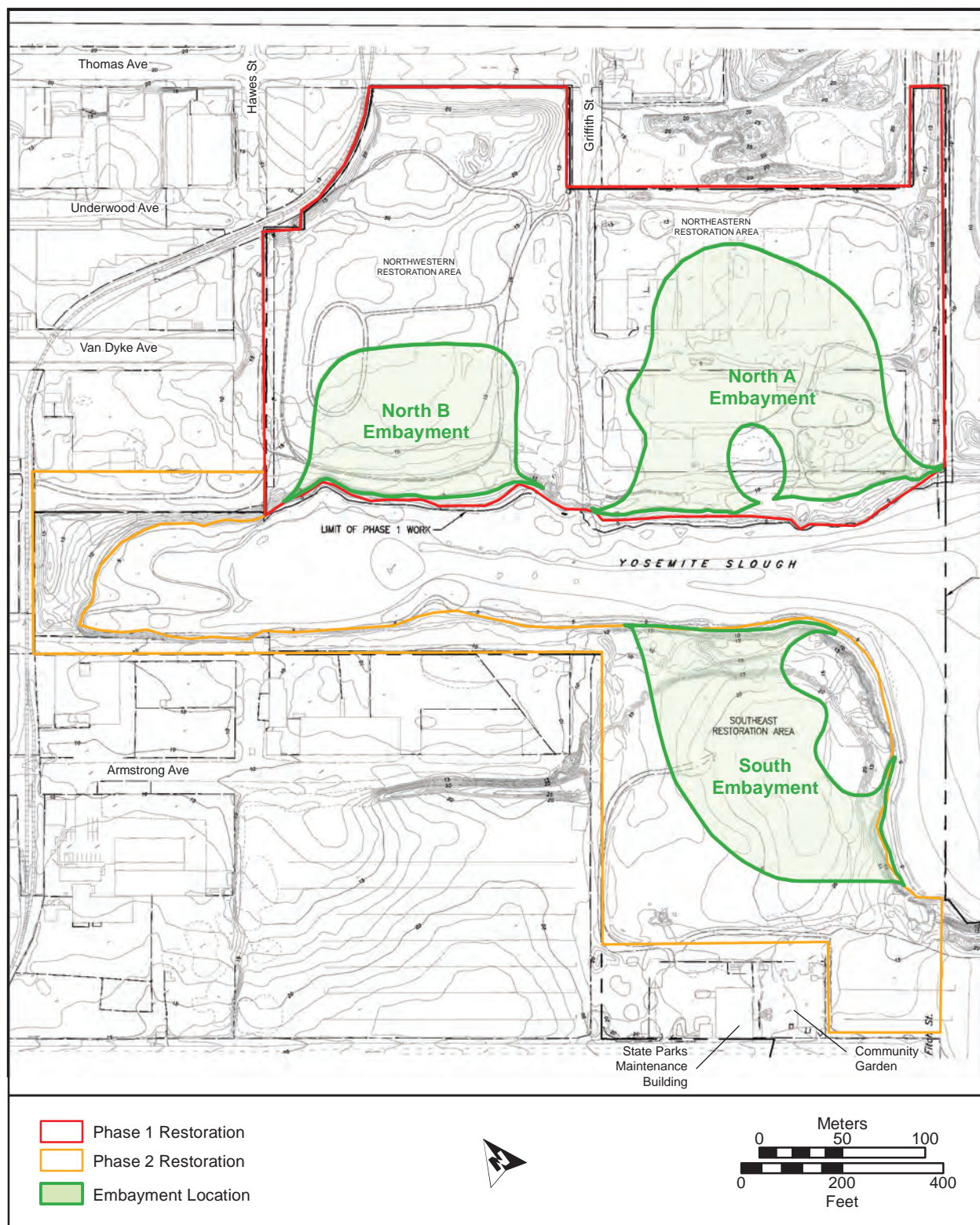


Figure 3. Project Area and Embayment Locations.



## 2. BACKGROUND

### GEOENVIRONMENTAL HISTORY AND SETTING

The San Francisco Bay Area has undergone a series of dramatic environmental changes during the period of human occupation (approximately the last 13,500 years). These changes have had a distinct effect on the distribution of plant and animal communities, which in turn had a direct bearing on past human settlement-subsistence strategies. Likewise, there is a close relationship between the nature and extent of large-scale environmental fluctuations and the timing of significant landscape changes, which consequently affected the preservation of archaeological sites from different time periods.

At the height of the last glacial maximum some 22,000 to 19,000 years ago, worldwide sea levels were at least 125 meters (410 feet) lower than today, and the Pacific coastline was located some 25 to 50 kilometers (about 15 to 30 miles) west of its current position (Atwater et al. 1977; Bard et al. 1996; Yokoyama et al. 2000). At that time, the Sacramento and San Joaquin rivers formed a single watercourse that flowed through the area now occupied by the San Francisco Bay and across the continental shelf before entering the Pacific Ocean near the Farallon Islands (Atwater et al. 1977). The area that now makes up San Francisco Bay was at that time a broad inland valley, crossed by numerous streams and rivers with incised channels that were graded to base levels significantly lower than today.

As the continental ice sheets began to melt some 19,000 years ago (Yokoyama et al. 2000), the world's oceans rose rapidly, causing the sea to migrate eastward across the continental shelf. During the Latest Pleistocene and Early Holocene (14,000-7000 cal BP), the sea rose a total of about 80 meters (~262 feet) at a relatively rapid average rate of about 11.4 meters (~37.4 feet) every 1,000 years, which was enough to fill the lower San Francisco Bay and its adjoining drainages. Between 7000 and 4000 cal BP (years Before Present), there was a dramatic decrease in the rate of sea-level rise worldwide (Stanley and Warne 1994), after which the sea inundated the Franciscan Valley at a more gradual rate of about 1.3 meters (4.3 feet) every 1,000 years (8.0 meters, or 26.2, feet total). This allowed sedimentation to keep pace with inundation, and permitted the formation of extensive tidal-marsh deposits during the Middle Holocene (Connor 1983).

As base levels increased in response to sea-level rise, the lower reaches of stream and river channels became choked with sediment that spilled onto the surface of existing fans and floodplains, forming large alluvial plains (Helley et al. 1979). The young bay continued to grow in size during the Late Holocene, and marshlands expanded in response to higher sea levels and the decomposition, compaction, and subsidence of inter-tidal deposits, particularly in the south bay. As a result, many older land surfaces were covered by at least two to three meters of Holocene-age alluvial deposits near the bay margins (Atwater et al. 1977:Plate 1; Borchardt 1992; Gmoser et al. 1999; Helley et al. 1979; Lee and Praszker 1969:60-63; Louderback 1951:90; Meyer 2000, 2001; Stewart et al. 2002; Treasher 1963:Figure 5). These older buried land surfaces are often marked by well developed soils that represent a significant stratigraphic boundary in the region.

Historic-era changes in the region included widespread erosion of the uplands, rapid sediment deposition in the lowlands, formation of deeply incised channels in alluvium-filled valleys, and the appearance of introduced (non-native) plant species. These changes, generally coinciding with the arrival of Spanish and other Euro-American settlers during the 1700s and 1800s (West 1989), have been documented in part by studies of wetland plants at locations throughout the Bay Area (Connor 1983; Duncan 1992; Mudie and Byrne 1980; Reidy 2001; Russell 1983).

During the late 1800s, protective vegetation cover was greatly reduced by intense drought and livestock grazing, which made the landscape particularly susceptible to erosion (Burcham 1957:171), as did many historic-era logging, mining, and agricultural practices. Finally, thick deposits of artificial fill were placed around the margins of the bay to reclaim the marshes and wetlands for human development (Lee and Praszker 1969). While some archaeological resources may have been partially or completely destroyed by historic-era development, others were obviously buried by artificial fill.

## SITE HISTORY

Historically the project area was situated within, and along the margins of, the San Francisco Bay south of Hunters Point. As shown on Figure 4, prior to development Yosemite slough was a series of narrow channels within a tidal marsh at the base of a small valley. Offshore of the slough was a small embayment bordered on the north and south by steep bedrock hills. Based on this mapping, historically the majority of the project area was situated within open water, with the exception of tidal marsh along the northwest margin and steep bedrock hillsides on both the north and south edges. Accordingly, recent Quaternary geologic mapping depicts the project area as situated primarily on Holocene Bay Mud, with the exception of the bedrock hills on the north and south edges (Figure 5; Knudsen et al. 2000).

Analysis of historic-era maps indicates that the project area remained relatively unchanged up through the 1930s, and the majority of the infilling of the bay occurred between 1947 and 1956. During this time the two bedrock hills bordering the project area were leveled. Infilling of the bay continued during the 1960s as access to the area was improved with the construction of Candlestick Park. By 1972 the approximate current shoreline was established, with the project area elevated five to 20 feet above sea level. Since the reclamation of the bay waters, the project area has been used for light industrial and commercial development, as well as a discharge location for storm and sanitary water overflow.

## LANDSCAPE EVOLUTION AND THE ARCHAEOLOGICAL RECORD

It is, perhaps, not surprising that the first human inhabitants of central California would have found the Franciscan Valley and interconnected lowlands attractive places to live. Prior to formation of the Bay, these were prominent river valleys, traversed by sinuous riparian forests and broad oak savanna that provided excellent habitat for tule elk (*Cervus elaphus*), deer (*Odocoileus* spp.), and pronghorn (*Antilocapra americana*), and for an earlier group of megafauna including mammoth, bison, horse, and camel, among others. Extensive watersheds would have assured the region's importance during drought, particularly in the Early and Middle Holocene, and the tributaries of larger rivers and streams offered an abundant supply of resident freshwater and anadromous fishes. Economically important plants would have also been abundant, as they were during the early historic period.

Yet with only a few important exceptions, archaeological sites dating older than a few thousand years have rarely been discovered in the Bay Area. In fact, fewer than 15% of the radiocarbon-dated sites in this region are older than 4,000 years, and fewer than 5% are older than 6,000 years (Meyer and Rosenthal 2000). This bias in the archaeological record can be explained, in part, by the dramatic changes which have occurred in the Bay Area landscape since humans first occupied the region more than 10,000 years ago. Many of the landforms originally available for human habitation were either submerged beneath the sea as it rose to flood the Franciscan Valley, or were buried by sediments widely deposited around the margins of the Bay-Delta estuary and in the many inland valleys of this region.

Beginning with the earliest systematic studies of central California and Bay Area prehistory, researchers have recognized that a significant portion of the archaeological record may lie buried in the fans and massive alluvial plains of the lowland valleys (Heizer 1949, 1950a, 1950b, 1952:9; Heizer and Cook 1953; Lillard et al. 1939:76; Meighan 1965:709; Schenck and Dawson 1929:294). Until recently, however, the importance of this relationship has been largely overlooked, as subsequent archaeological studies have only occasionally included detailed analyses of site soils and sediments. Of those studies that have specifically incorporated a geological perspective, almost all were initiated after buried archaeological materials were discovered accidentally (Bard et al. 1989, 1992; Fredrickson 1966; Henn et al. 1972; LaJoie et al. 1980). With rare exceptions (Banks et al. 1984; Bickel 1978; Fredrickson 1980), it has only been in the last ten years that archaeologists have explicitly sought to understand the relationship between buried archaeological sites and development of the central California landscape (Allen et al. 1999; Meyer 1996; Meyer and Rosenthal 1997; Rosenthal and Meyer 2004a, 2004b; White 2002, 2003).

Numerous recent studies demonstrate that the broader San Francisco Bay Area has undergone prolonged periods of landform stability, interrupted by several episodes of widespread erosion and relatively rapid deposition (Atwater 1980; Biggar et al. 1978, Borchardt 1992; Borchardt et al. 1980; Helley et al. 1979; Lettis 1982, 1985,



Figure 4. Historic-Era Landscape of the Project Area with Known and Predicted Prehistoric Archaeological Site Locations.





Figure 5. Project Area overlain on Quaternary Geology Map.



1988; Marchand and Allwardt 1981; Meyer 1996, 2000; Meyer and Rosenthal 1997; Pape 1978; Rogers 1988; Rosenthal et al. 1995; Shlemon and Begg 1972, 1975; Swan et al. 1977; White 2002; among many others). These cycles are expressed as a series of laterally extensive, well-developed buried soils found throughout the depositional landforms of this region. Geoarchaeological studies in the Bay Area have further confirmed a strong correlation between these buried soils and buried archaeological deposits (Allen et al. 1999; Meyer 1996; Meyer and Rosenthal 1997; Rosenthal and Meyer 2004a, 2004b; White 2002).

On a local and regional level, these processes have had a disproportional effect on the structure of the archaeological record, because many sites have been buried by one or more episodes of sediment deposition, particularly those dating to the Early and Middle Holocene. As discussed below, archaeological components from these time periods are indeed buried in the lowlands and are frequently found in association with Middle and Early Holocene buried soils. Thus, there is a strong correlation between Holocene-age landforms, buried soils, and buried archaeological remains in the Bay Area. Since the vast majority of the region's known archaeological record dates to after about 3,000 years ago, future archaeological studies should anticipate the possibility that older and/or under-represented portions of the archaeological record will be discovered in association with buried land surfaces that are 3,000 years or more in age. When such sites are identified, they are likely to have an elevated level of significance from the standpoint of archaeological research and of regulatory compliance.

## BURIED ARCHAEOLOGICAL SITES IN THE BAY REGION

Buried archaeological deposits associated with buried soils have been discovered in virtually every major valley in the San Francisco Bay Area (Meyer 1996; Meyer and Rosenthal 1997; Rosenthal and Meyer 2004a). For example, buried sites or site components have been identified finds at several locations (e.g., CA-ALA-576, -586, -566; CCO-548, -637, -696) in the East Bay that range between about 5,300 and 550 years old (Figure 6; Gmoser et al. 1999; Meyer and Rosenthal 1997; Price et al. 2006; Rosenthal et al. 2006; Tiley 2001)

On the San Francisco peninsula, buried shell middens and human skeletal remains have been exposed in the Late Holocene sand dunes that underlie the city's financial district. These include SFR-112, -113, and -114, all of which are less than about 2,500 years old (Pastron and Walsh 1988a, 1988b), and SFR-151/H that dates to around 1,000 years old (Byrd et al. 2010). In addition, a 5,000-year-old human skeleton (SFR-28) was found in downtown San Francisco during construction of the Bay Area Rapid Transit (BART) tunnel. These remains were found in buried marsh deposits at a depth of approximately 18 meters (59 feet) below the historic-era ground surface and more than seven meters (23 feet) below modern sea level (Henn et al. 1972). A human skeleton dated to 4200 cal BP was also uncovered 3.7 meters (12.1 feet) beneath the surface of San Francisco Bay during dredging operations off of Coyote Point (Leventhal 1987). This discovery occurred not far south of, and in a similar geomorphic setting to, the Yosemite Slough Restoration project area.

Along with the discovery of the "Stanford Man" skull (SCL-33/609) in 1922, the San Francisquito Creek floodplain has yielded a number of deeply buried human skeletons and other features associated with buried soils, including those found at the site of "Stanford Man II" (SCL-613) and at University Village (SMA-77). A deeply buried hearth and a human interment known as the "Sunnyvale Man" were found in association with a buried soil exposed in a storm drain east of Sunnyvale (LaJoie et al. 1980; Moratto 1984). More recently, the "Sunnyvale Red Burial" was exposed by deep construction in downtown Sunnyvale at site SCL-832 (Cartier 2002). Radiocarbon and stratigraphic evidence indicate that these burials are Middle Holocene and later in age.

This brief review of buried sites around the San Francisco Bay demonstrates the potential for such deposits in virtually all of the lowland valleys and bay margins of this region. As many of these constitute the oldest known archaeological deposits in the Bay Area, their research potential is quite high, and therefore these sites tend to have elevated levels of significance with respect to National Register of Historic Places and the California Register of Historical Resources eligibility criteria. The presence of human remains at most of these sites also has implications for Native American heritage and further emphasizes the need to identify such resources early in the planning process.

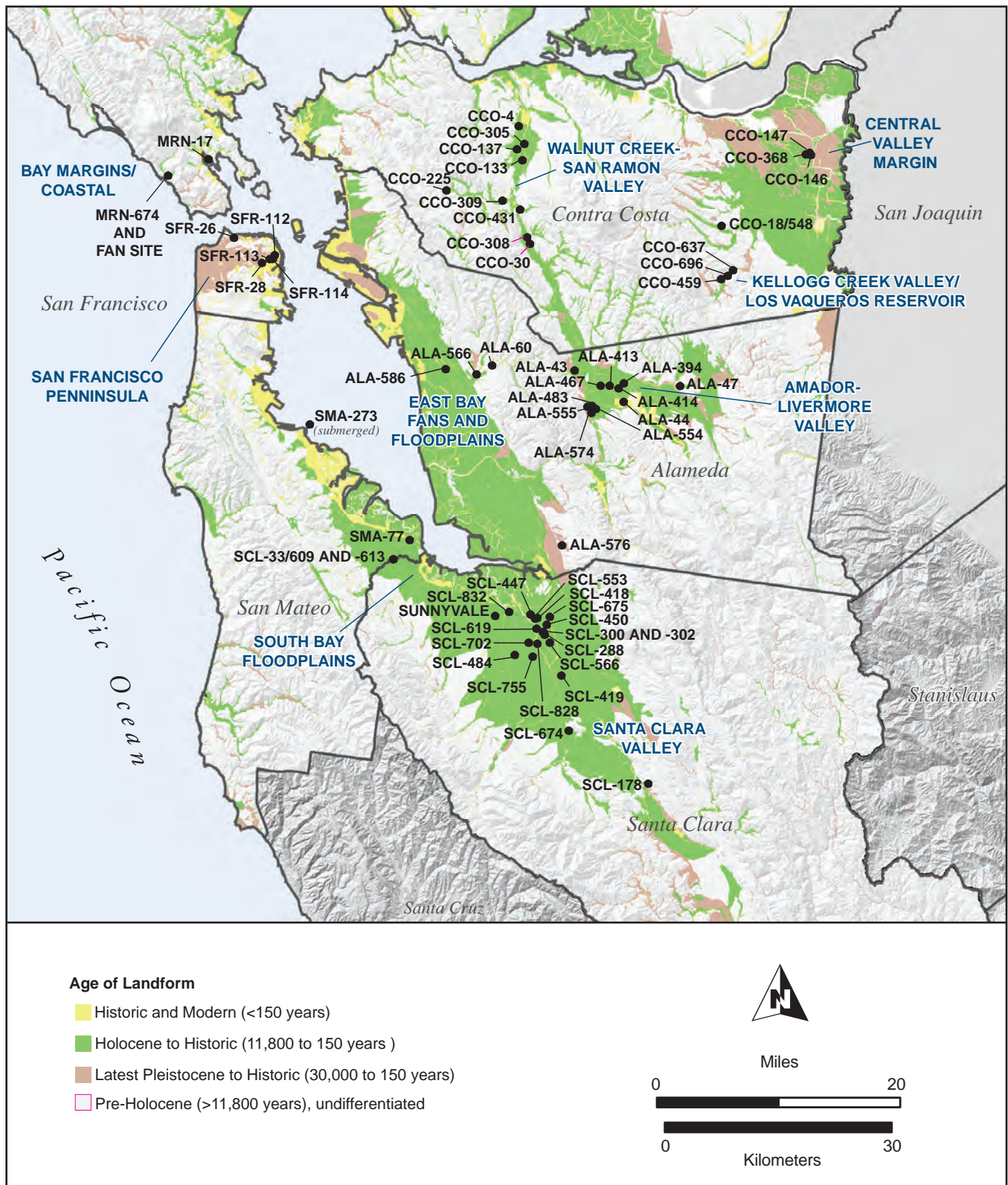


Figure 6. Selected Buried Sites in the Southern San Francisco Bay Area.

## BURIED SITE PROBLEM

Although it has long been suspected that natural processes have obscured many archaeological sites in California (Heizer 1949:39-40, 1950a, 1952:9; Lillard et al. 1939; Moratto 1984:214), archaeological visibility has not been treated as a significant problem as it has in other parts of North America. The lack of geoarchaeological studies is an ongoing problem for researchers seeking to understand the relationship between regional site distribution patterns and demographic and settlement-subsistence change in central California (Meyer and Rosenthal 1997).

Over the past decade, however, it has become increasingly apparent that a significant portion of the archaeological record has been buried by the natural geological processes in the San Francisco Bay area and surrounding region (e.g., Rosenthal and Meyer 2004a, 2004b; Meyer and Rosenthal 2007, 2008). Recent geoarchaeological studies emphasize that these changes have produced a significant bias in the types of archaeological deposits that can be identified through traditional pedestrian survey, and underscore the correlation between buried archaeological deposits and the presence of now-buried land surfaces (Meyer 1996, 2000; Meyer and Dalldorf 2004; Meyer and Rosenthal 1997, 2008; Rosenthal and Meyer 2004a, 2004b).

For instance, it is not known if the relative paucity of Early and Middle Holocene-age archaeological sites in the region indicates that human populations were substantially lower during these periods or, alternatively, if it reflects a visibility and sampling bias related to large-scale landscape changes (Rosenthal and Meyer 2004a). The presence of multiple buried Holocene-age soils in the Guadalupe River floodplain in Santa Clara County supports the contention that the early archaeological record has been severely biased by natural geological processes (Kaijankoski 2007; Meyer 2000). Thus, if researchers are to understand the relationship(s) between regional site distributions and demographic and settlement-subsistence changes, then the potential effects of landscape change on the archaeological record must be considered.

At the same time, the potential for buried archaeological sites is a practical problem for resource managers who must make a good-faith effort to ensure that project activities do not inadvertently affect, or adversely impact, potentially important buried archaeological deposits. Early detection of buried archaeological deposits also avoids the potential for costly delays that may occur when resources are discovered after project construction has begun and late-discovery protocols are necessary. Recognizing these problems, this study represents an effort to identify archaeological resources that may be buried within the proposed project area.

## PREVIOUS ARCHAEOLOGICAL STUDIES

No archaeological survey report is known to have been produced for this project. The Initial Study/Mitigated Negative Declaration (IS/MND) report details cultural resources background studies conducted for the project, which included a records search and site visit (WRA 2006).

The records search identified one previously recorded archaeological site located near the project area. CA-SFR-110, also known as the Griffith-Shafter Mound, was identified during a subsurface augering for the San Francisco Clean Water Program (Banks 1981). Intact shell midden was identified in four augers excavated along Griffith Street, extending for approximately 122 meters (400 feet) northeast-southwest, from Revere Street to halfway between Shafter and Thomas Avenue. Culturally sterile augers determined the boundaries of the site along Griffith Street; however the northwest and southeast boundaries are unknown. Apparently intact shell midden was encountered at 2.4 to 3.0 meters (eight to ten feet) below surface capped by artificial fill. This midden deposit was a maximum of 2.1 meters (seven feet) thick in the center of the site; however this decreased to 1.2 meters (four feet) thick in both directions towards the site boundaries on Griffith Street. SFR-110 is situated approximately 60 meters (197 feet) northeast of the northern edge of the project area. Historically this site was located on the northeast side of the steep bedrock hillside adjacent to a small marsh and extending into a small lagoon (see Figure 4). It is unknown if the location of this site extending into the historic lagoon is due to a (1) a possible georeferencing error with historic-era maps; (2) archaeological materials being pushed into the lagoon during infilling (and therefore being in secondary context); or (3) a result of rising sea levels submerging the site.

Additionally, an unrecorded potential prehistoric site, known as the Thomas-Hawes Mound, is situated near the northern edge of the project area. The IS/MND incorrectly identifies this site as SFR-7, which is a substantial prehistoric site located approximately 1.3 kilometers (0.8 miles) southwest of the southern edge of the project area (Figure 7). The existence of a shell mound near the intersection of Thomas Ave and Hawes Street was predicted by Olmsted et al. (1980) based on mapping of a mound on the 1852 US Coast Survey map, which also correctly identified the location of the shell mound that was later recorded as SFR-110. Subsurface explorations by Banks (1981) conducted along Thomas Ave within and near the intersection of Hawes Street consisted of four augers drilled to 4.9 to 5.5 meters (16 to 18 feet) below surface. Three augers (#'s 1-3) identified only artificial fill, one of which (#2), however, contained pockets of redeposited midden. It was later learned that these three augers may have been placed in the location of a former levee. The fourth auger (#4) encountered an intact natural landform at 3.0 meters (ten feet) below surface, however no archaeological materials were observed. Based on this, the results of this field investigation were inconclusive. Historically the intersection of Thomas Ave and Hawes Street was situated on flat dry land adjacent to the Yosemite Slough marsh, a setting likely to have attracted prehistoric human occupation (see Figure 4). This stands in contrast to the open water, tidal marsh, and steep bedrock hillsides of the project area.

A site visit to the project area by EDAW personnel on July 27, 2005 confirmed that the project area is covered in historic-era and modern fill, in addition to modern buildings and structures. For these reasons no assessment of the presence or absence of archaeological sites in the project area was made. Based on this the IS/MND stipulated that a qualified archaeologist must monitor any project related ground disturbing activities.

Given that construction monitoring as a means of archaeological identification can be time consuming and costly, California State Parks requested that Far Western conduct Extended Phase I subsurface archaeological explorations in advance of project construction. Based on the background information presented above, the portions of the project area with the greatest potential for archaeological sites to be buried under artificial fill are the historically terrestrial areas in the northwest (south of modern day Thomas Avenue), and along the southern margin (north of modern day Carrol Avenue). Additionally, while the historic-era location of the bay indicates a low potential for Late Period prehistoric sites, a potential does exist for older sites to be submerged under the bay in the central portions of the project area. In both scenarios, the key variable is if vertical project impacts will intersect either the historic-era surface, or a submerged formally terrestrial surface.





Figure 7. Project Area in Relation to Known and Predicted Prehistoric Site Locations.

### 3. SCOPE OF WORK

#### FIELD AND LABORATORY METHODS

Exploratory testing was conducted in the APE on July 6 and 7, 2011 under the supervision of Far Western Geoarchaeologist Philip Kaijankoski. A hydraulic coring device, known commercially as a “Geoprobe,” was used to explore subsurface deposits for buried archaeological materials (Figure 8). This method has proven successful at identifying buried archaeology sites elsewhere in the San Francisco Bay Area (Byrd et al. 2010; Kaijankoski 2008; Kaijankoski et al. 2009). The Geoprobe was used as an alternative to mechanical excavation because of soil contamination, high groundwater levels along the bay margins, and because some vertical impacts exceeded the range of backhoe excavation.

The exact location of the cores in the project area was determined in the field based on safety and assess constraints (buildings, underground utilities), in addition to the ongoing results of coring. Core locations were chosen not only to target deep impact areas, but also where archaeological sites are most likely to be buried under artificial fill to assist with future management of the recreation area. Twenty-one cores were drilled to depths of 0.6 to 7.3 meters (two to 24 feet) below surface to gain a representative sample of the subsurface deposits (Figure 9). During drilling two cores in the northern portion of the project area refusal was encountered immediately (depicted as an “X” on Figure 9), which likely identifies the location of the leveled bedrock hill. Each core was designated according to the numerical sequence in which it was drilled and the location of each core was recorded in the field with a Global Positioning System (GPS) unit. The depths, descriptions, and interpretations of each stratum and/or soil horizon identified in each core drilled for this investigation can be found in Appendix A. Due to the nature of Geoprobe sampling, it is reasonable to assume a certain margin of error ( $\pm$  about 0.3 meter [one foot]) for the depths below surface for the stratigraphic contacts presented in Appendix A.

The samples from subsurface deposits were recovered and stored in hard plastic (PVC) liners that were 1.2 meters (four feet) long, and 4.7 centimeters (1.85 inches) in diameter. Each liner was placed in a dual walled push tube that was hydraulically driven to the appropriate depth to capture a continuous core sample for the desired interval. The liners were then extracted from the push tube and labeled to indicate their location, depth interval, and orientation (i.e., top or bottom), with details noted on core logs. All samples were transported to the laboratory at Far Western, where they were stored and allowed to air-dry in a protected place until they could be described and subsampled. When an intact natural landform was identified in the lab it was wet screened through 1/16-mesh to recover any archaeological materials. Although relatively small, the core samples were large enough to: (1) determine the presence or absence of archaeological materials; and (2) allow determination of the nature and extent of the subsurface deposits.

#### Stratigraphic Identification and Soil Description

Natural and/or cultural stratigraphy was identified whenever possible by carefully examining the deposits exposed in the cores. Stratigraphic units (strata) were identified on the basis of physical composition, superposition, relative soil development, and/or textural transitions (i.e., upward fining sequences) characteristic of discrete depositional cycles. In the field, each stratum exposed in exploration trenches was assigned a Roman numeral (I, II, III, etc.) beginning with the oldest or lowermost stratum (sometimes bedrock) and ending with the youngest or uppermost stratum. Buried soils (also called paleosols), representing formerly stable ground surfaces, were identified in the field on the basis of color, structure, horizon development, bioturbation, lateral continuity, and the nature of the upper boundary (contact) with the overlying deposit, as described by Birkeland et al. (1991), Holliday (1990), Retallack (1988), and Waters (1992), among others.

Master horizons describe in-place weathering characteristics and were designated by upper-case letters (A, B, C); an R designates solid bedrock. These are preceded by Arabic numerals (2, 3, etc.) when the horizon is associated with a different stratum (i.e., 2Cu); number 1 is understood but not shown. The upper part of a complete soil profile is usually called the A-horizon, with a B-horizon being the zone of accumulation in the





a) Drilling Core 12



b) Drilling Core 13

Figure 8. Fieldwork Photos.

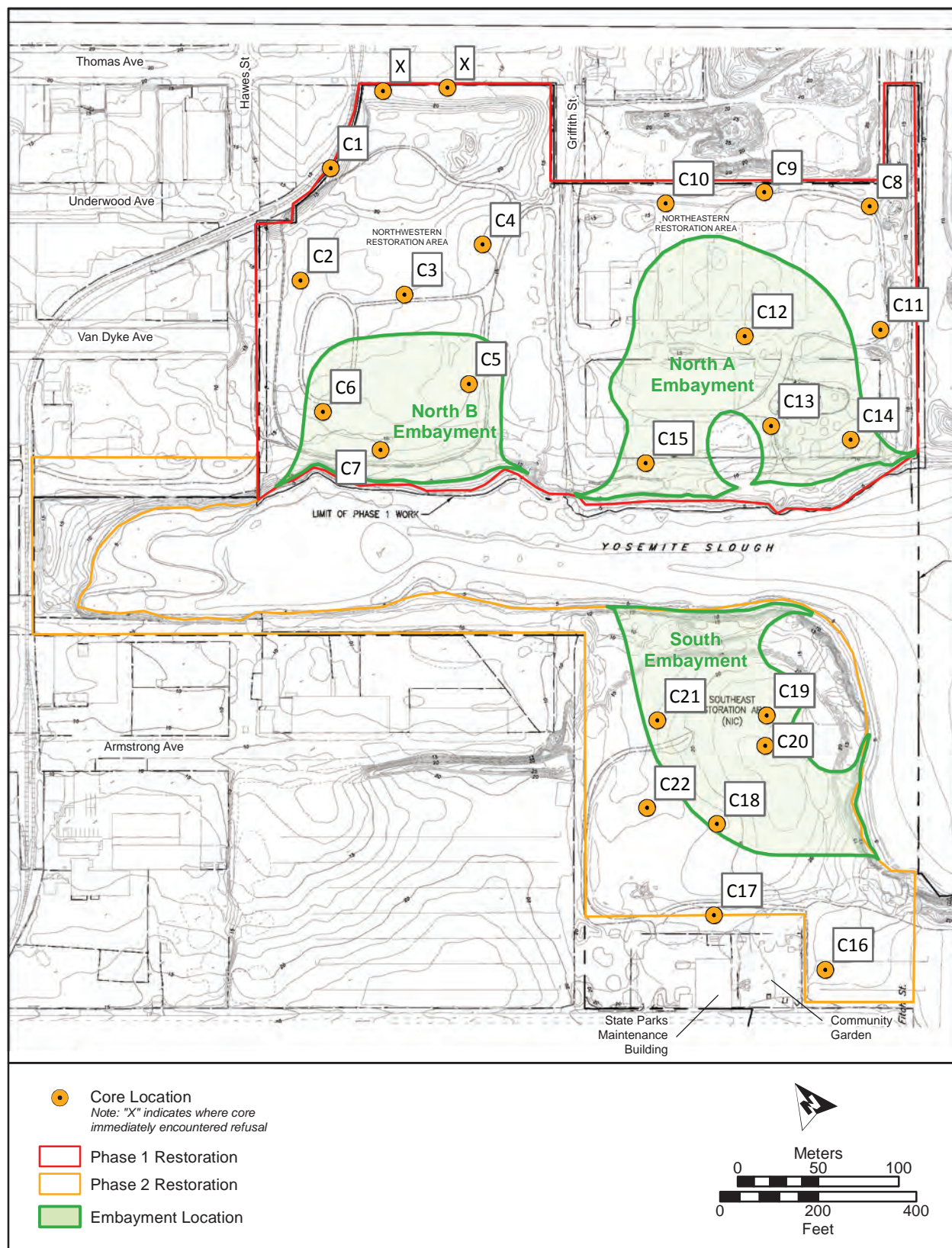


Figure 9. Project Area and Core Locations.



middle of a profile, and the C-horizon representing the relatively unweathered parent material in the lower part of a profile. Lower-case letters were used to designate subordinate soil horizons (Table 1). Combinations of these numbers and letters indicate the important characteristics of each major stratum and soil horizon; they are consistent with those outlined by Birkeland et al. (1991), Schoeneberger et al. (1998), and the USDA Soil Survey Staff (1998).

Table 1. Key for Subordinate Soil Horizons.

SUBORDINATE HORIZONS	DESCRIPTION
p	Disturbed zone (e.g., artificial fill or plow zone)
b	Horizon buried at location where described (not used with C-horizons)
g	Gleying from reduction or removal of iron
ox	Oxidized iron and other materials (subsurface)
t	Illuvial accumulation of silicate clay in the subsurface
u	Unweathered parent material (used only with C-horizons)

#### 4. STUDY RESULTS

This section presents the results of geoarchaeological coring in the project area; describes the age, nature, and extent of the major geologic units identified; and the resulting potential for buried archaeological sites in the project area. An examination of exposed deposits resulted in the identification of three distinct stratigraphic units, as described below in chronological order. These include bedrock (Stratum I), estuarine deposits (Stratum II), and artificial fill (Stratum III). No archaeological materials were identified as a result of this investigation.

Stratum I consists of bedrock identified at the surface in two cores drilled on the northwestern margin of the project area (depicted as “X” on Figure 9). The immediate refusal encountered by the geoprobe indicates that this is the location of the bedrock hillside depicted on the historic-era map (see Figure 4) that was leveled during the twentieth century.

Stratum II consists of estuarine deposits lacking evidence of near surface weathering. This stratum generally consisted of black (10YR 2/1) massive silt loam grading to, or stratified within, dark greenish gray (Gley 1 4/10Y) sand containing common large clam shell fragments. The nature of this stratum, particularly the lack of aerial weathering indicative of a terrestrial landform, indicates that it was formed within a subtidal environment of the San Francisco bay. This corresponds with the historic-era mapping depicting the majority of the project area as primarily an open water bay environment. This stratum was identified only in the lower portion of cores 6, 12, 15, and 22 at depth ranging from 3.7 to 6.7 meters (12 to 22 feet) below surface. Given that this stratum represented the only intact natural landform identified in the project area it was wet screened to identify any prehistoric archaeological materials that may be present, albeit likely in a naturally redeposited/reworked context. While shell was commonly found, it was determined to be of natural origin based on (1) the context in which was identified; (2) the large size of the clam shell and; (3) the lacked of any indications of cultural modification (e.g., burning).

Stratum III generally consists of variable color and texture gravely fill with minor amounts of disturbed natural deposits (Ap). This unit was encountered at the surface in every core extending to depths ranging from 3.7 to 6.7 meters (12 to 22 feet) below surface. The nature and stratigraphic position of this unit indicate that it is the result of artificial filling from bay and wetland reclamation. No archaeological materials were found associated with this unit.

#### SUMMARY AND BURIED SITE POTENTIAL

The results of this investigation document that the project area is underlain by a thick deposit of artificial fill that overlies an estuarine deposit and/or truncated bedrock hillside. The truncated bedrock of Stratum I has no potential for archaeology sites. The estuarine deposits of Stratum II were deposited within an aquatic environment and have a low potential for prehistoric archaeological materials. Additionally, wet screening of this stratum indicates that it does not contain naturally redeposited/reworked prehistoric archaeological materials. Lastly, the artificial fill of stratum III has no potential to contain intact archaeological deposits. While redeposited archaeological materials may be contained within this fill, none were observed during this investigation. Taken together the project area has a low potential for prehistoric archaeological materials within the depths sampled by this investigation.

Of the 15 cores drilled north of Yosemite Slough, intact marsh deposits (Stratum II) were encountered in only three of these at depths ranging from 3.7 to 4.9 meters (12 to 15.5 feet) below surface. Since current project plans call for excavation to depths ranging from 2.4 to 3.0 meters (eight to ten feet) below surface in this area, the findings indicate that only artificial fill deposits will be excavated by construction north of Yosemite Slough (Phase 1). Similarly, while the project impacts proposed for south of Yosemite Slough are considerably deeper, up to 5.5 meters (18 feet) below surface, the results of this study indicate that the artificial fill in this area is considerably thicker (Table 2). As intact marsh deposits (Stratum II) were only encountered in one core at a depth of 6.7 meters (22 feet) below surface, it appears that only artificial fill deposits will be excavated during construction south of Yosemite Slough (Phase 2). Based on these findings, no further archaeological identification efforts are recommended for this project as it is currently designed.

Table 2. Summary of Cores Drilled in Project Area.

CORE #	MAXIMUM DEPTH	NOTES
1	1.2 m (4 ft)	All artificial fill. Refusal at bottom of core.
2	4.9 m (16 ft)	All artificial fill
3	4.9 m (16 ft)	All artificial fill
4	4.9 m (16 ft)	All artificial fill possibly overlying bedrock
5	4.9 m (16 ft)	All artificial fill
6	5.2 m (17 ft)	Artificial fill overlying intact estuarine deposits at 4.3 meters (14 feet). Marsh wet screened with negative results
7	4.9 m (16 ft)	All artificial fill
8	4.9 m (16 ft)	All artificial fill
9	4.9 m (16 ft)	All artificial fill
10	4.9 m (16 ft)	All artificial fill
11	4.9 m (16 ft)	All artificial fill
12	4.9 m (16 ft)	Artificial fill overlying intact estuarine deposits at 3.7 meters (12 feet). Marsh wet screened with negative results
13	4.9 m (16 ft)	All artificial fill
14	4.9 m (16 ft)	All artificial fill
15	4.9 m (16 ft)	Artificial fill overlying intact estuarine deposits at 4.7 meters (15.5 feet). Marsh wet screened with negative results
16	6.1 m (20 ft)	All artificial fill. Refusal at bottom of core.
17	4.3 m (14 ft)	All artificial fill. Refusal at bottom of core.
18	5.5 m (18 ft)	All artificial fill. Refusal at bottom of core.
19	0.6 m (2 ft)	All artificial fill. Refusal at bottom of core.
20	0.6 m (2 ft)	All artificial fill. Refusal at bottom of core.
21	4.9 m (16 ft)	All artificial fill. Refusal at bottom of core.
22	0-7.3 m (0-24 ft)	Artificial fill overlying intact estuarine deposits at 6.7 meters (22 feet). Marsh wet screened with negative results

## 5. CONCLUSIONS

This subsurface geoarchaeological investigation for the Yosemite Slough Restoration Project was conducted to determine the presence or absence of buried archaeological materials in advance of project construction. Twenty-two cores were drilled in this area to depths of 0.6 to 7.3 meters (two to 24 feet) below surface, which often exceeded the proposed depth of project impacts. No archaeological materials were identified in any of the core samples even after select buried marsh deposits in the cores were wet screened. Additionally, the borings demonstrated that project subsurface impacts will only excavate artificial fill that has no potential to contain intact archaeological deposits. For these reason no further archaeological identification efforts, including construction monitoring, are recommended for the project as currently planned.



## REFERENCES CITED

- Allen, Rebecca, A. Medin, R. S. Baxter, B. Wickstrom, C. Young Yu, Julia G. Costello, Greg White, A. Huberland, H. M. Johnson, Jack Meyer, and Mark Hylkema
- 1999 *Upgrade of the Guadalupe Parkway, San Jose Historic Properties Treatment Plan*. Past Forward, Richmond; KEA Environmental, Inc., Sacramento; Foothill Resources, Ltd., Mokelumne Hill; California State University, Chico; and Sonoma State University, Rohnert Park. Submitted to the California Department of Transportation, District 4, Oakland, California.
- Atwater, Brian F.
- 1980 Attempts to Correlate Late Quaternary Climatic Records Between San Francisco Bay, The Sacramento-San Joaquin Delta and the Mokelumne River, California. Unpublished Ph.D. dissertation, University of Delaware.
- Atwater, Brian, Charles Hedel, and Edward Helley
- 1977 *Late Quaternary Depositional History, Holocene Sea Level Changes, and Vertical Crustal Movement, Southern San Francisco Bay, California*. US Geological Survey Professional Paper, No. 1014. US Government Printing Office, Washington, DC.
- Banks, Peter M.
- 1981 *Subsurface Archaeological Investigations at CA-SFR-7, the Griffith-Shafter Mound, and the Thomas-Hawes Mound, along the Sunnydale-Yosemite Alignment 2A-1, City and County of San Francisco*. California Archaeological Consultants, Inc, Oakland, California. Prepared for the San Francisco Clean Water Program.
- Banks, Peter M., R. Orlins, and H. McCarthy
- 1984 *Final Report, Walnut Creek Project: Test Excavation and Evaluation of Archaeological Site CA-CCO-431, Contra Costa County, California*. California Archaeological Consultants, Inc., Oakland, California.
- Bard, E., B. Hamelin, M. Arnold, L. Montaggioni, G. Cabioch, G. Faure, and F. Rougerie
- 1996 Deglacial Sea-Level Record from Tahiti Corals and the Timing of Global Meltwater Discharge. *Nature* 382:241-244.
- Bard, James C., Colin I. Busby, and L. S. Kober
- 1989 *Final Report Archaeological Data Recovery of CA-ALA-60 Located on Route 580, Castro Valley, Alameda County, California*. Basin Research Associates, Inc., San Leandro, California. On file, California Department of Transportation, District 4, Oakland, California.
- Bard, James C., Colin I. Busby, Michael R. Fong, Robert M. Harmon, Melody E. Tannam, Donna M. Garaventa, Angela M. Banet, S. A. Jarvis, Steven J. Rossa, and Ranbir S. Sidhu
- 1992 *Archaeological Site Testing Report, CA-ALA-483, Laguna Oaks Project, Pleasanton, Alameda County, California*. Basin Research Associates, Inc., San Leandro, California. On file, Northwest Information Center, California Historical Resources Information System, Sonoma State University, Rohnert Park, California.
- Bickel, Polly M.
- 1978 Changing Sea Levels along the California Coast: Anthropological Implications. *Journal of California Anthropology* 5(1):6-20.

Biggar, Norma, Lloyd S. Cluff, and Hans Ewoldsen

- 1978 *Geologic and Seismologic Investigations, New Melones Dam Project, California*. Woodward-Clyde Consultants, San Francisco, California. Report submitted to United States Army Corps of Engineers, Sacramento District, Sacramento, California.

Birkeland, Peter W., Michael N. Machette, and Kathleen M. Haller

- 1991 *Soils as a Tool for Applied Quaternary Geology*. Miscellaneous Publications 91-3. Utah Geological and Mineral Survey Division of Utah Department of Natural Resources.

Borchardt, Glenn

- 1992 *Holocene Slip Rate of the Hayward Fault, Union City, California*. Final Technical Report to the United States Geological Survey. Soil Tectonics, Berkeley, California.

Borchardt, Glenn, Salem Rice, and Gary Taylor

- 1980 *Paleosols Overlying the Foothills Fault System near Auburn, California*. California Division of Mines and Geology, Sacramento, California.

Burcham, Levi T.

- 1957 *California Range Land*. California Division of Forestry, Sacramento.

Byrd, Brian F., Philip Kaijankoski, Jack Meyer, Adrian Whitaker, Rebecca Allen, Meta Bunse, and Bryan Larson

- 2010 *Archaeological Research Design and Treatment Plan for the Transit Center District Plan Area, San Francisco, California*. Far Western Anthropological Research Group, Inc., Davis, California. Submitted to the San Francisco Planning Department.

Cartier, Robert

- 2002 The Sunnyvale Red Burial: CA-SCL-832. In *Proceedings of the Society of California Archaeology, Volume 15*, pp. 49-52. Society for California Archaeology.

Conner, Cathy L.

- 1983 *Holocene Sedimentation in Richardson Bay, California*. US Geological Survey Open-File Report No. 83-312. Menlo Park, California.

Duncan, Faith L.

- 1992 Botanical Reflections of the Encuentro and the Contact Period in Southern Marin County, California. Doctoral dissertation, Department of Anthropology, University of Arizona, Tucson.

Fredrickson, David A.

- 1966 CCO-308: The Archaeology of a Middle Horizon Site in Interior Contra Costa County, California. M.A. Thesis, Department of Anthropology, University of California, Davis.
- 1980 Changes in Prehistoric Exchange Systems in the Alamo Locality, Contra Costa County, California. In *Toward a New Taxonomic Framework for Central California Archaeology: Essays by James A. Bennyhoff and David A. Fredrickson*, edited by Richard E. Hughes, pp. 57-63. Contributions of the University of California Archaeological Research Facility 52, published in 1994, Berkeley.

Gmoser, Glenn, Jeff Rosenthal, William Hildebrandt, and Pat Mikkelsen

- 1999 *Archaeological Survey of the I-680 Corridor between Dublin and Milpitas in Alameda and Santa Clara Counties for the "Sunol" Grade Southbound Improvement Project with Results of Extended Phase II/Phase II Archaeological Investigations at ALA-574, 575, 576.* California Department of Transportation, District 4, Oakland.

Heizer, Robert F.

- 1949 *The Archaeology of Central California, I: The Early Horizon.* University of California Anthropological Records 12(1):1-84. University of California Press, Berkeley.
- 1950a Observations on Early Man in California. *Papers on California Archaeology* 1-5. University of California Archaeological Survey Reports 7:5-10. University of California, Berkeley.
- 1950b Archaeology of CCo-137, the "Concord Man" Site. *Papers on California Archaeology* 6-9. University of California Archaeological Survey Reports 9:1-5. University of California, Berkeley.
- 1952 A Review of Problems in the Antiquity of Man in California. *Symposium of the Antiquity of Man in California.* University of California Archaeological Survey Reports 16:1-10. University of California, Berkeley.

Heizer, Robert F., and S. F. Cook

- 1953 "Capay Man," An Ancient Central California Indian Burial. *Papers on California Archaeology: 21-26.* University of California Archaeological Survey Reports 22:24-26, University of California, Berkeley.

Helley, Edward J., K. R. LaJoie, W. E. Spangle, and M. L. Bair

- 1979 *Flatland Deposits of the San Francisco Bay Region, California - Their Geology and Engineering Properties, Their Importance to Comprehensive Planning.* Professional Paper 943. Department of the Interior, United States Geological Survey, Washington, DC.

Henn, Winfield, Thomas Jackson, and J. Schlocker

- 1972 Buried Human Bones at the 'Bart' Site, San Francisco. *California Geology* 25(9):208-209.

Holliday, Vance T.

- 1990 Pedology in Archaeology. In *Archaeological Geology of North America*, Norman P. Lasca and Jack Donahue, pp. 525-540. Centennial Special Volume 4, Geological Society of America, Boulder, Colorado.

Kaijankoski, Philip

- 2007 *Preliminary Prehistoric Site Screening for the Heinlenville/San Jose Corporation Yard Project, San Jose, California.* Anthropological Studies Center, Sonoma State University, Rohnert Park, California. Prepared for the Redevelopment Agency, City of San Jose.
- 2008 *A Geoarchaeological Investigation of the Presidio Main Parade Ground, San Francisco, California.* Anthropological Studies Center, Sonoma State University, Rohnert Park, California. Prepared for the Presidio Trust Archaeology Lab, San Francisco.

Kaijankoski, Philip, Brian F. Byrd, and Jack Meyer

- 2009 *Extended Phase I Archaeological Investigations for the Quint Street Bridge Replacement Project, Caltrain Peninsular Corridor, San Francisco, California.* Far Western Anthropological Research Group, Inc., Davis, California. Submitted to the Federal Transportation Administration and the Peninsula Corridor Joint Powers Board.

- Knudsen, Keith L., Janet M. Sowers, Robert C. Witter, Carl M. Wentworth, and Edward J. Helley
- 2000 *Preliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine-County San Francisco Bay Region, California: A Digital Database*. US Geological Survey Open-File Report 00-444, Online Version 1.0, Menlo Park, California, <http://pubs.usgs.gov/of/2000/of00-444/>, Updated September 22, 2005, Accessed December 2006.
- Lajoie, Kenneth R., Etta Peterson, and Bert A. Gerow
- 1980 Amino Acid Bone Dating: A Feasibility Study, South San Francisco Bay Region, California. In *Biochemistry of Amino Acids*, edited by P. E. Hare, pp. 477-489. Wiley, New York.
- Lee, Charles H., and Michael Praszker
- 1969 Bay Mud Developments and Related Structural Foundations. In *Geologic and Engineering Aspects of San Francisco Bay Fill*, edited by Harold B. Goldman, pp. 41-85. Special Report 197, California Division of Mines and Geology, San Francisco.
- Lettis, William R.
- 1982 *Late Cenozoic Stratigraphy and Structure of the Western Margin of the Central San Joaquin Valley, California*. United States Geologic Survey Open-File Report 82-526.
- 1985 Late Cenozoic Stratigraphy and Structure of the West Margin of the Central San Joaquin Valley, California. In *Soils and Quaternary Geology of the Southwestern United States*, edited by David L. Weide, pp. 65-114. Special Paper 203, Geological Society of America, Boulder, Colorado.
- 1988 Quaternary Geology of the Northern San Joaquin Valley. In *Studies of the Geology of the San Joaquin Basin*, edited by Stephan Graham and Hilary Clement Olson, pp. 60:333-351. Pacific Section of the Society of Economic Paleontologists and Mineralogists, Los Angeles, California.
- Leventhal, Alan
- 1987 *Final Report on the Human Skeletal Remains Recovered from Prehistoric Site: CA-SMA-273, Coyote Point Marina, San Mateo, CA*. San Jose State University, San Jose. Prepared for Department of General Services, County of San Mateo, Redwood City, California.
- Lillard, Jeremiah B., Richard F. Heizer, and Franklin Fenenga
- 1939 *An Introduction to the Archaeology of Central California*. Sacramento Junior College Department of Anthropology Bulletin 2. Board of Education of the Sacramento City Unified School District, Sacramento, California.
- Louderback, George D.
- 1951 Geologic History of San Francisco Bay. In *Geologic Guidebook of the San Francisco Bay Counties: History, Landscape, Geology, Fossils, Minerals, Industry, and Routes to Travel*. State of California Department of Natural Resources Bulletin 154:75-94. Division of Mines, San Francisco.
- Marchand, Denis E., and Alan Allwardt
- 1981 *Late Cenozoic Stratigraphic Units, Northeastern San Joaquin Valley, California*. US Geological Survey Bulletin 1470, Scale 1:125,000. US Government Printing Office, Washington, DC.
- Meighan, Clement W.
- 1965 Pacific Coast Archaeology. In *The Quaternary of the United States*, edited by H. E. Wright and D. Frey, pp. 709-719. Princeton University Press, Princeton, New Jersey.



Meyer, Jack

- 1996 Geoarchaeological Implications of Holocene Landscape Evolution in the Los Vaqueros Area of Eastern Contra Costa County, California. M.A. Thesis, Cultural Resources Management, Department of Anthropology, Sonoma State University, Rohnert Park.
- 2000 *A Geoarchaeological Study of the Guadalupe Parkway Corridor, State Route 87, San Jose, Santa Clara County, California*. Anthropological Studies Center, Sonoma State University, Rohnert Park, California. Submitted to the California Department of Transportation, District 04, Oakland, and KEA Environmental, Inc., San Diego, California.
- 2001 *A Geoarchaeological Study for the Proposed Alameda Highway 238 Widening Project, Alameda County, California*. In *Extended Phase I Assessment of Prehistoric Archaeological Site, CA-ALA-586, for the Highway 238 Widening Project*, by Shelly Tiley, Appendix A. Archaeological Research Center, California State University, Sacramento. Prepared for the California Department of Transportation (District 4), Oakland, California.

Meyer, Jack, and Graham Dalldorf

- 2004 *Geoarchaeological Studies along Portions of the East Sonora Bypass Corridor, Tuolumne County, California (in progress)*. Anthropological Studies Center, Sonoma State University, Rohnert Park. Submitted to the California Department of Transportation, District 10, Stockton, California.

Meyer, Jack, and Jeffrey S. Rosenthal

- 1997 Archaeological and Geoarchaeological Investigations at Eight Prehistoric Sites in the Los Vaqueros Reservoir Area, Contra Costa County. In *Los Vaqueros Project Final Report*. Anthropological Studies Center, Sonoma State University, Rohnert Park, California. Submitted to the Contra Costa Water District, Concord. Report on file, Northwest Information Center, Sonoma State University, Rohnert Park, California.
- 2000 More than 9,000 Years Ago. Paper presented at Beneath Our Feet: A 10,000 Year Human and Natural Legacy in the East Bay. Oakland Museum of California, James Moore Theater, November 18, 2000.
- 2007 *Geoarchaeological Overview of the Nine Bay Area Counties in Caltrans District 4*. Far Western Anthropological Research Group, Inc., Davis, California. Submitted to California Department of Transportation, Office of Cultural Resources, District 4, Oakland, California.
- 2008 *A Geoarchaeological Overview and Assessment of Caltrans District 3—Cultural Resources Inventory of Caltrans District 3 Rural Conventional Highways*. Far Western Anthropological Research Group, Inc., Davis, California. Submitted to the California Department of Transportation, District 3, North Region, Marysville, California.

Moratto, Michael J.

- 1984 *California Archaeology*. Academic Press, New York.

Mudie, P. J., and R. Byrne

- 1980 Pollen Evidence for Historic Sedimentation Rates in California Coastal Marshes. *Estuarine and Coastal Marine Science* 10:305-316.

Olmsted, Roger, Nancy Olmsted, Allan Pastron, and Jack Pritchett

- 1980 *Research Design to Locate Nelson Shellmounds Subject to Impact by San Francisco Sewer Route 2 A-1*. San Francisco Clean Water Program. Prepared by Resource Consultants and Archeo-Tec.

- Pape, D. A.
- 1978 Terraced Alluvial Fills in Contra Costa County, California. M.A. Thesis, University of California, Berkeley.
- Pastron, A. G., and M. R. Walsh
- 1988a *Archaeological Excavations at CA-SFR-112, the Stevenson Street Shellmound, San Francisco, California*. Archives of California Prehistory 21. Coyote Press, Salinas, California.
- 1988b *Archaeological Excavations at CA-SFR-113, the Market Street Shell Midden: A Prehistoric Archaeological Site, San Francisco, California*. Archives of California Prehistory 25. Coyote Press, Salinas, California.
- Price, Heather, Aimee Arrigoni, Jenni Price, Eric Strother, and Jim Allan
- 2006 *Archaeological Investigations at CA-CCO-309 Rossmoor Basin, Contra Costa County, California*. William Self Associates, Inc, Orinda, California. Prepared for County of Contra Costa Department of Public Works, Martinez, California.
- Reidy, Liam Michael
- 2001 *Evidence of Environmental Change over the Last 2,000 Years at Mountain Lake, in the Northern San Francisco Peninsula, California*. M.A. Thesis, University of California, Berkeley.
- Retallack, Greg J.
- 1988 Field Recognition of Paleosols, Special Paper 216. In *Paleosols and Weathering through Geologic Time: Principles and Applications*, Juergen Reinhardt and Wayne R. Sigleo, Geological Society of America, Boulder, Colorado.
- Rogers, J. David
- 1988 Pleistocene to Holocene Transition in Central Contra Costa County, California. In *Field Trip Guide to the Geology of the San Ramon Valley and Environs*, pp. 29-51. Northern California Geological Society, San Ramon, California.
- Rosenthal, Jeffrey S., and Jack Meyer
- 2004a *Landscape Evolution and the Archaeological Record: A Geoarchaeological Study of the Southern Santa Clara Valley and Surrounding Region*. Center for Archaeological Research at Davis Publication 14, University of California, Davis.
- 2004b *Cultural Resources Inventory of Caltrans District 10 Rural Conventional Highways - Volume III: Geoarchaeological Study; Landscape Evolution and the Archaeological Record of Central California*. Far Western Anthropological Research Group, Inc., Davis, California. Submitted to California Department of Transportation, District 10, Stockton. On file, Central California Information Center, California State University, Stanislaus.
- Rosenthal, Jeffrey S., Jack Meyer, and Greg White
- 1995 *Archaeological Investigations at the Crazy Creek Sites, CA-LAK-1682 and CA-LAK-1683, Lake County, California*. Anthropological Studies Center, Sonoma State University, Rohnert Park, California. Mary Grace Pawson, Winzler and Kelly, Consulting Engineers, Santa Rosa, California.

Rosenthal, Jeffrey S., Jack Meyer, Jim Nelson, Denise Furlong, Tim Carpenter, and Eric Wohlgemuth

- 2006 *Results of Limited Geoarchaeological and Archaeological Study of CA-CCO-18/548, John Marsh Historic Park, Brentwood, California*. Far Western Anthropological Research Group, Inc., Davis, California. Prepared for California Department of Parks and Recreation.

Russell, Emily W. B.

- 1983 Pollen Analysis of Past Vegetation at Point Reyes National Seashore, California. *Madroño* 30(1):1-11.

Schenck, W. E., and E. J. Dawson

- 1929 *Archaeology of the Northern San Joaquin Valley*. University of California Publications in Archaeology and Ethnology 25(4):289-413. University of California Press, Berkeley.

Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and W. D. Broderson

- 1998 *Field Book for Describing and Sampling Soils*. National Soil Survey Center, Natural Resources Conservation Service. US Department of Agriculture, Lincoln, Nebraska.

Shelmon, R. J., and E. L. Begg

- 1972 *A Holocene Soil-Landscape Chronology, Southwestern Sacramento Valley California*. Proceedings of the 22nd International Geographical Congress, Montreal. University of Toronto Press.
- 1975 Late Quaternary Evolution of the Sacramento-San Joaquin Delta, California. In *Quaternary Studies*, edited by R. P. Suggate and M. M. Cresswell, pp. 259-265. INQUA Congress, The Royal Society of New Zealand Bulletin 13. Wellington.

Stanley, Daniel Jean, and Andrew G. Warne

- 1994 Worldwide Initiation of Holocene Marine Deltas by Deceleration of Sea-Level Rise. *Science* 265:228-229.

Stewart, Suzanne, Jack Meyer, and Mike Newland

- 2002 *Phase One Investigations for the Fort Baker Archaeological Survey, Golden Gate National Recreation Area, Marin County, California*. Anthropological Studies Center, Sonoma State University, Rohnert Park. Prepared for Golden Gate National Recreation Area, National Park Service, San Francisco. On file, Golden Gate National Recreation Area, National Park Service, San Francisco, California.

Swan, F. W., III, K. L. Hanson, and W. D. Page

- 1977 Landscape Evolution and Soil Formation in the Western Sierra Nevada Foothills, California. In *Soil Development, Geomorphology and Cenozoic History of the Northeastern San Joaquin Valley and Adjacent Area, California*, edited by M. J. Singer, pp. 1-7, 300-311. University of California Press, Davis, California.

Tiley, Shelly

- 2001 *Extended Phase I Assessment of Prehistoric Archaeological Site, CA-ALA-586, for the Highway 238 Widening Project*. Archaeological Research Center, Department of Anthropology, California State University, Sacramento. Submitted to the California Department of Transportation, District 04, Oakland.

Treasher, Ray C.

- 1963 Geology of the Sedimentary Deposits in San Francisco Bay, California. In *Short Contributions of California Geology*, pp. 11-24. Special Report 82, California Division of Mines and Geology, San Francisco.

United States Department of Agriculture (USDA) Soil Survey Staff

- 1998 *Keys to Soil Taxonomy, Eighth Edition*. US Department of Agriculture, Natural Resources Conservation Service, Washington, DC.

Waters, Michael R.

- 1992 *Principles of Geoarchaeology: A North American Perspective*. The University of Arizona Press, Tucson, Arizona.

West, James G.

- 1989 Late Pleistocene/Holocene Vegetation and Climate. In *Prehistory of the Sacramento River Canyon, Shasta County, California*, edited by Mark E. Basgall and William R. Hildebrandt, pp. 36-55. Center for Archaeological Research at Davis Publication 9, University of California, Davis.

White, Greg

- 2002 *Cultural Diversity and Culture Change in Prehistoric Clear Lake Basin: Final Report of the Anderson Flat Project*. Center for Archaeological Research at Davis Publication 13, University of California, Davis.
- 2003 *Population Ecology of the Prehistoric Colusa Reach*. Doctoral dissertation, Department of Anthropology, University of California, Davis.

WRA Environmental Consultants

- 2006 Final Initial Study Mitigated Negative Declaration, Candlestick Point Recreation Area Yosemite Slough Restoration.

Yokoyama, Yusuke, Kurt Lambeck, Patrick De Deckker, Paul Johnsto, and L. Keith Fifield

- 2000 Timing of the Last Glacial Maximum from Observed Sea-Level Minima. *Nature* 406:713-716.



**APPENDIX A**  
**CORE DESCRIPTIONS**

## Appendix A. Core Soil Descriptions.

Core #	Horizon Depth - Meters (ft.)	Horizon Description (all colors 10YR moist unless noted)	Interpretations
1	0-1.2 m (0-4 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core. Refusal.	Artificial fill
2	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
3	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
4	0-4.6 m (0-15 ft.)	<b>Ap:</b> Mixed artificial fill at surface with an abrupt lower contact	Artificial fill
	4.6-4.9 m (15-16 ft.)	<b>2Cr:</b> Yellowish brown angular sandstone in sandy loam matrix extending to the base of the core.	Bedrock?
5	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
6	0-4.3 m (0-14 ft.)	<b>Ap:</b> Mixed artificial fill at surface with an abrupt lower contact.	Artificial fill
	4.3-5.2 m (14-17 ft.)	<b>2Ag:</b> Stratified deposit of dark greenish gray (Gley 1 4/10Y) sandy loam with massive structure, very friable consistency, and common large clam shell fragments, and black clay loam with massive structure and very friable consistency, extending to base of core. Wet screened for archaeological materials, negative.	Intact aquatic marsh
7	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
8	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
9	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
10	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
11	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
12	0-3.7 m (0-12 ft.)	<b>Ap:</b> Mixed artificial fill at surface with an abrupt lower contact.	Artificial fill
	3.7-4.9 m (12-16 ft.)	<b>2Ag:</b> Black stratified sandy loam and clay loam with massive structure and very friable consistency extended to the base of core. Wet screened for archaeological materials, negative.	Intact aquatic marsh
13	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
14	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core.	Artificial fill
15	0-4.0 m (0-13 ft.)	<b>Ap1:</b> Mixed artificial fill at surface with an abrupt lower contact.	Artificial fill
	4.0-4.7 m (13-15.5 ft.)	<b>Ap2:</b> Black sand with single-grain structure and loose consistency with an abrupt lower contact.	Dune sand utilized as fill
	4.7-4.9 m (15.5-16 ft.)	<b>2Ag:</b> Black silt loam with massive structure and very friable consistency extended to the base of core. Wet screened for archaeological materials, negative.	Intact aquatic marsh
16	0-6.1 m (0-20 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core. Refusal.	Artificial fill
17	0-4.3 m (0-14 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core. Refusal.	Artificial fill
18	0-5.5 m (0-18 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core. Refusal.	Artificial fill
19	0-0.6 m (0-2 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core. Refusal.	Artificial fill
20	0-0.6 m (0-2 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core. Refusal.	Artificial fill
21	0-4.9 m (0-16 ft.)	<b>Ap:</b> Mixed artificial fill at surface extending to the base of core. Refusal.	Artificial fill
22	0-6.7 m (0-22 ft.)	<b>Ap:</b> Mixed artificial fill at surface with an abrupt lower contact.	Artificial fill
	6.7-7.3 m (22-24 ft.)	<b>2Ag:</b> Black silt loam with massive structure and very friable consistency, grading to dark greenish gray (Gley 1 4/10Y) sand with single-grain structure and loose consistency and common large clam shells extended to the base of core. Wet screened for archaeological materials, negative.	Intact aquatic marsh